Title

A Knowledge System and Methods of Business Alerting and Business Analysis

Field of the Invention

The present invention relates to knowledge or expert systems and to methods of business processing. More in particular a novel computer knowledge system and novel methods of business processing making use of knowledge relations are disclosed.

Background of the Invention

Knowledge or expert systems are known in the art. An example of such a system is the Service Assurance Center system, commercially provided by the company BMC Software, the publicly available information about this system being incorporated herein by reference. The Service Assurance Center provides Information Technology organizations a view of:

- how services are performing;
- whether services are available at any given moment around the world; and
- how both its internal staff and external customers are using its application services.

The Service Assurance Center system is monitoring Information Technology (IT) systems, including software application parts, and the technical Infra Structure (IS), including hardware components. This monitoring is executed by synthetic transactions wherein, for example, a Personal Computer emulates the behavior of a user. Hereby information can be gathered whether and to what extent parts of the IT systems are correctly working or are correctly emulating a physical infrastructure.

In an article by Lewis, L, et al., "Incorporating Business Process Management into Network and Systems Management", Proceedings - ISADS 97 -Third International Symposium on Autonomous Decentralized Systems (Cat. No. 97TB100111), Proceedings of the International Symposium on Autonomous Decentralized Systems, ISADS 97, Los Alamitos, CA, USA, IEEE Comput. Soc. Press, USA, page(s) 385 - 392, an approach towards autonomous, decentralized monitoring and management of Business Processes (BP) is disclosed.

To realize BP management, existing techniques in integrated network and systems management are employed. The system is made up of agents, among others an alarm monitoring agent, who's responsibility is to collect and forward alarms of the operation of hardware and software components used in a computer environment operative for enabling a plurality of business processes, a reasoning agent for correlating alarms, and an alarm notification agent displaying alarms concerning BP to users, for taking corrective actions manually or automatically.

The system disclosed correlates business processes or functions to changes or disturbances in the IT system, i.e. the software components, as well as to the IS system parts, i.e. the hardware components, making up the computer environment.

Problem Definition and Aim of the Invention

The prior art knowledge or expert systems disclosed above just provide a tool for controlling and/or managing the IT/IS systems being part of a business and for correlating business processes or functions to changes or disturbances in the IT/IS system.

In practice, business processes or functions are associated with one another, such that malfunctioning of one or a few of the business processes, for example, can have a tremendous impact on the operation or execution of other business processes or functions, either directly or indirectly enabled by the computer environment.

In a telecommunications network, for example, failure of a switch may not only involve the call processing of that particular switch, but also payment transactions and other vital data transactions, on a local or even global scale.

There is a further problem in the art in that the IT/IS systems that are developed to manage or monitor the business processes or functions are becoming more and more complex. Therefore it is difficult to analyze the impact of functional errors in parts of the IT/IS systems in relation to the performance of the system as a whole. Prior art solutions do not tackle this problem to a sufficient level.

Accordingly, there is a need to provide a knowledge system that not only communicates about a single or a few business processes in terms of its or their relation to the performance of the underlying IT/IS system, but also on how the operation of affected business processes influence the operation or execution of other business processes of the computer system.

Summary of the Invention

In accordance with a first aspect of the present invention, there is provided a computer knowledge system, for operation in a computer environment using a plurality of hardware and software components operatively arranged for enabling a plurality of business processes, the computer knowledge system comprises:

- a monitoring agent, arranged for collecting data providing information about the operation of the hardware and software components;

- a relational database, storing data providing information about the operation of the business processes and error data relating to erroneous operation of the hardware and software components; and

- a user interface, arranged for providing information about the operation of the business processes using the data collected by the monitoring agent and the data stored in the relational database,

the relational database being arranged for providing information towards the user interface about the impact on the operation of the business processes of an erroneous operation of the hardware and software components.

The knowledge system according to the present invention couples information about one or more business processes or functions to one or more software and hardware components used in the computer environment, while the knowledge system provides information about the impact on the execution of business processes or functions towards a user interface in case of erroneous operation of the software and hardware components.

The software and hardware components can include all kind of Information Technology infrastructures known to the person of skill in the art, including network connections, files, database, and software applications. The software components furthermore can be coupled to the physical infrastructure on which the business processes or functions are based.

The business processes or functions may include, for example, a business process communication, such as a fixed-telephone telecommunication connection, and may include the IT system including the operating system and IS hardware of the business process and the network connections of the telephone network.

In the case of a the above telecommunications system, for example, with the present invention, failure of a switch will not only be reported as to affecting the call processing of that switch

but also as to the impact thereof to other business processes, such as the financial transactions handled through this switch.

Thus, the business processes or functions information provided by the present invention are broader than setting up a one-to-one connection between an error identification in a software component and a corresponding troubleshooting message to a user interface, while the information is provided in the "language" of the business processes.

The business process or functions, for example, can also include financial processes such as investment funds management or financial transaction business processes or production installation processes such as the actual production processes in a chemical plant or for car manufacturing. The business processes or functions are automated an preferably integrated business processes or functions with a complexity of individual business steps that are related one to the other.

In a further embodiment of the computer knowledge system according to the present invention, the relational database comprises data identifying functional transactions within the business processes and dependencies between functional transactions of the business processes, wherein the user interface is arranged for correlating the error data and the functional transactions data for providing the information about the impact on the business processes of an erroneous operation of the hardware and software components.

The coupling of information about one or more business processes or functions to one or more software and hardware components can be done in several ways. The coupling can include a correlation between one or more business processes or functions to one or more software components and/or include a straightforward link with a number of call-in procedures between one or more business processes or functions to one or more software and hardware components. At least part of the coupled information can be stored in the relational database or stored on the computer environment. The relational database for example can be based on ACCESS, or can be based on database software provided by ORACLE, SYBASE, or SEQUEL SERVER or any other relational database software known to the person of skill in the art.

A main purpose of the computer knowledge system according to the present invention is a goal-oriented processes control. To this end, in a yet further embodiment of the system according to the invention, the user interface is arranged for providing the information about the business processes indicating at least one of a group comprising:

- the extent to which business processes are influenced by a disturbance in the software

and hardware components;

- the extent to which business processes are influenced by a functional error in the hardware and software components;

- the extent to which business processes are influenced by a functional error in the hardware and software components, which functional error cannot directly be monitored;

- the extent to which business processes are influenced by an externally applied change, such as a predetermined change for performing impact analyses, in the hardware and software components; and

- the extent to which business processes are available in the case of an erroneous operation of the hardware and software components.

The information provided can benefit from historical data about erroneous operation of the hardware and software components. To this end, in accordance with an other embodiment of the computer knowledge system of the invention, the system comprises a historical database, storing historical data about erroneous operation of the hardware and software components and the impact thereof on the business processes, wherein the user interface is arranged for providing the information about the impact on the business processes of an erroneous operation of the hardware and software components using the historical data.

Business process monitoring and business process control generally involves several user groups, both internally and externally of the computer environment on which the business processes are internally or externally executed. The several user groups have different requirements as to the type and presentation of the relevant information.

Accordingly, in a still further embodiment of the computer knowledge system according to the present invention, the user interface is arranged for providing the information about the impact on the enabling of the business processes of an erroneous operation of the hardware and software components in a predetermined format adapted to the user of the information.

In a more detailed embodiment, the computer knowledge system according to the present invention is arranged for providing the information relevant to the different user groups in terms of:

- functionality of the business processes;
- usability of the business processes;
- maintainability of the business processes;
- efficiency of the business processes;
- reliability of the business processes; and

- changeability of the business processes.

The coupling of information about one or more business processes or functions to one or more software and hardware components can be done in several ways. The coupling can include a correlation between one or more business processes or functions to one or more software components and or may include a straightforward link with a number of call-in procedures between one or more business processes or functions to one or more software and hardware components. At least part of the coupled information can be stored in the relational database which stored on said computer environment.

In a further embodiment of the system according to the invention, the monitoring agent, the relational database and the user interface connect through a central agent, among orders, providing processing support.

The user interface can be part of the computer environment, but the user interface can also be external to the computer environment and be linked by a communication channel to the knowledge system. The user interface can be a computer screen, a mobile telephone, or a flat panel or whatever user interface suitable for the purpose of the present invention and known to the person of skill in the art. The user interface can also include the World-Wide-Web internet or intranet infrastructure.

The information to be collected about the operation of the hardware and software components, is in a further embodiment of the invention, acquired in that the monitoring agent is arranged for collecting:

- workflow data provided by the computer environment;
- system monitoring data; and
- data accumulated in a data warehouse of the computer environment.

Data accumulated in a data warehouse will, in general, have a low topicality. Workflow data are acquired using an automated Workflow Management System (WMS) or ERP system or systems. System monitoring data is collected on-line from the infrastructure or derived from IT application and system monitoring.

In a prefered embodiment of the invention, the monitoring agent comprises a knowledge module, operating with a business flow monitor and a component monitor for collecting data providing information about the operation of the business processes and the hardware and software components.

The knowledged module, in a yet further embodiment of the computer knowledge system of

the invention, is arranged for collecting data with respect to:

- availability of critical components;
- communications performance between critical components;
- critical messages in application and system log files;
- synthetic transaction from end user view;
- application and system processes;
- database and critical table(s) data availability; and
- system resource availability and performance.

The user interface may be arranged for providing information on an automated basis or on a subscription basis, for example by issuing notification messages, standard reports, as an HTML (Hyper Text Markup Language) page and in a form of a trouble ticket. Further, in accordance with the present invention, the information towards the user interface, in order to reduce the information flow, may be provided if the impact on the execution of the business processes exceeds a predeterminated threshold value.

In a second aspect of the present invention, a method of providing information or alerting about the operation of business processes in a computer environment using a plurality of hardware and software components operatively arranged for enabling a plurality of business processes, the method comprises:

- collecting data providing information about the operation of the hardware and software components;
- storing data providing information about the operation of the business processes and error data relating to erroneous operation of the hardware and software components; and
- providing information towards a user interface about the operation of the business processes using the collected and stored data,

the data are processed for providing information towards the user interface about the impact on the enabling of the business processes of an erroneous operation of the hardware and software components.

In a third aspect of the present invention, there is provided a method of analyzing the operation of business processes in a computer environment using a plurality of hardware and software components operatively arranged for enabling a plurality of business processes, the method comprises:

- collecting data providing information about the operation of the hardware and software components;

- storing data providing information about the operation of the business processes and error data relating to erroneous operation of the hardware and software components; and

- providing information towards a user interface about the operation of the business processes using the collected and stored data,

the data are processed for providing information towards the user interface about the impact on the enabling of the business processes of an erroneous operation of the hardware and software components.

In a fourth aspect, the present invention provides a computer program stored on a computer readable medium, as well as a such a computer readable medium, for use with a computer knowledge system and methods of business information, alerting and analyses as disclosed above.

The computer readable medium can be a floppy disk, a CD-rom, Digital Video Disk (DVD) or other memory or data carrier known to the skilled person. A number of terms used throughout this description are further detailed here below in order to complement the understanding of the person of skill in the art of these terms.

A knowledge system can also be defined as an expert system. An error in the IT/IS components can include changes of whatever nature including disfunctioning or disturbances of the software components.

Brief Description of the Drawings

Figure 1a and 1b schematically show the architecture of an example embodiment of a knowledge system of the present invention, including additional software components.

Figure 2a shows an embodiment of the infrastructure of an example business process of fixed-telephone connections.

Figure 2b shows a number of operations being part of a business process.

Figure 3 shows an embodiment of a user interface showing geographic information about a business process.

Figure 4 schematically shows dependencies within the functionality of the NERVECENTER knowledge system according to a best mode embodiment of the invention.

Detailed Description of the Invention

For the purpose of teaching of the invention, a preferred embodiment of a knowledge system and methods of the invention are described in the sequel. It will be appreciated by the person skilled in the art that other alternative and equivalent embodiments of the invention can be conceived and reduced to practice without departing form the true spirit of the invention, the scope of the invention being limited only by the appended claims.

Figure 1a schematically shows the architecture of an example embodiment of a knowledge system of the present invention.

In the upper part of the figure, several business processes are shown. The business processes or functions, for example, may include financial processes, financial transaction business processes, production installation processes, telecommunication processes, etc.

As can be clearly viewed from the figure, the business processes or functions have several interdependencies, indicated by the arrowlinks between the business processes. An erroneous operation of one or a plurality of the business processes will have an impact on the operation or execution of another or a plurality of other business processes.

The business processes are enabled by Information Technology (IT) components or building blocks, in the present application also indicated by the term software components, and InfraStructure (IS) components or building blocks, in the contekst of the present patent application generally called hardware components. The IS/IT building blocks form part of a computer environment enabling the business processes. In figure 1a the IS/IT building blocks are shown in the lower part of the figure. The knowledge system of the present invention is depicted in the middle of figure 1a. The knowledge system comprises two main parts, an Information Services (IS) part and an Application & Database Building Blocks part. Figure 1b schematically shows the architecture of an example embodiment of a knowledge system of the present invention, including additional software components.

The knowledge system of the invention includes the part SI which is a relational database 13 that includes the information about the coupling or the relations between the software and hardware (IS/IT) components and the business processes or functions.

Incoming signals 11 from the IS/IT components 10 are fed to a central agent 12 including a monitoring agent (PATROL) 18. The signals may include the signaling of a change or a disturbance

or an error in the software components. The central agent 12 may include functionality on filtering of the incoming signals. The signals from the central agent 12 thereafter are fed to the relational database 13. However, the signals can also be fed directly to the relational database 13.

In the relational database, links are available and made between the software and hardware components 10 and the corresponding business processes or functions. Links are then automatically generated via the central agent 12 to user interfaces 16-17 and a database 15 that stores the occurrence of incoming signals, also called the historical service degradation database 15.

A signal that is generated towards the user interfaces 16-17 and the historical service degradation database 15 is popping up on the user interface. From the user interface several reports can be drawn on the impact of the business processes affected by the signaling due to a change or disturbance or error in the software and hardware components, among others using the contents of the historical database.

Further functionality can be included in the knowledge system by smoothly integrating new software components and interfacing to other knowledge systems or other computer environments.

In the development of the relational database 13, there are a number of steps that can be followed. A first step includes the analysis of the business flow and the analysis of the IS components that support the business process flow. This step includes the identification of functional transactions within the business process, the documentation of possible errors and known failure points, and of known problems within the business transaction flow and the IT/IS components. A next step may include the definition of the relationship and dependencies between the individual business steps or transactions within the process, and the dependencies between the individual business steps or transactions within the process and software components of the IT infrastructure supporting the business process on the other hand.

The mapping of the business and IT/IS infrastructure includes the definition of the correlation of the impact of the IT/IS infrastructure events on the business process flow. Furthermore can be provided a definition of threshold alarm levels and alerts and the definition of data presentation formats and reporting formats, which can be made user dependent, on a subscription bases or automatically. The results of these steps are stored as dependencies in the relational database and as links to separate software and hardware components and as separate software components. There can be provided further a software application that monitors the business process flow and an application that monitors the software components. The further functionality of

links to a user interface and other functionalities of the knowledge system are to be provided.

Figure 2a shows an embodiment of the infrastructure of an example business process of fixed-telephone connections. Figure 2b indicates a number of operations being part of the business process.

Figure 3 shows, according to a best mode embodiment of the invention, a user interface showing geographic information about the business process. The business process, as stated above, is one of business processes involved with fixed-telephone connections. One of the parts of this system is the CIA (Client Order Entrance Application) module.

This CIA is interfacing for the entrance of client orders from the consumer market. The CIA is the first part of a chain of software components that link the client order ultimately to the switch connection orders in the telephone central units. The client orders are registered on line. The CIA has interfaces to software components shown in figure 2a including modules with client data, infrastructure data, telephone number data, rent data and billing data.

For example the module KANVAS provides to the CIA information about the technical infrastructure such as cables, connections etc. CIA provides to KANVAS the changes that are needed in the technical infrastructure for performing the client order. NUMBES for example contains a database of telephone numbers. If a new number is generated and added to the database, an operator connection is made. The CIA is a 16-bit application and can run under a WINDOWS environment on a PC such as a Fujitsu PC or a DELL PC or any similar PC known to the person of skill in the art. The CIA only contains configuration files; data are stored in the other software components. The different interfaces are based on RPC (T-AAK). The performance of the KANVAS systems is monitored with SYSTAR software. Performance problems of KANVAS lead to a stacking of transactions in the CIA. In order to cope with such problems a knowledge system of the invention such as the NERVECENTER (NC) software shell is to be implemented in order to provide incident control, problem control, change control, configuration management and service level management.

The dependencies in the business process of fixed-telephone connections are analyzed up to the level of the software and hardware components that constitute or monitor the technical process of fixed-telephone connections. These dependencies are stored in a relational database. Scripts are coupled hereto and these scripts generate WebPages.

Figure 4 schematically shows dependencies within the functionality of the NERVECENTER knowledge system according to the best mode embodiment of the invention. A prototype software in an ACCESS database is reduced to practice.

An example of the add-on of the NERVECENTER software to business process of fixed-telephone connections is shown in figure 2b and 3. The geographic extension of the fixed-telephone connections over the Netherlands is shown. The non-availability of parts of the network in different parts of the Netherlands is, in a practical embodiment, indicated by red lights on the map of figure 3. The business steps or operations of the list of figure 2b that can not be executed, are indicated in red as well. These signals on the user interface are generated through error functions in the software components such as the KANVAS component.

A detailed description of the best made embodiment of the NERVECENTER software is given here below.

Nervecenter Pilot KPN Datacenter

File overview

1. Deliverables

The Service Informer environment can be subdivided into the following parts:

- Miscellanea
- Documentation
- Presentations
- Development
- ServiceInformer

the latter directory containing all files relevant for the operational environment.

Directory / file name	Description
Miscellanea	
Documentation	
Service Informer - Ontwerp.doc	Functional and technical design
Service Informer - Handleiding.doc	User manual
Service Informer - APH.doc	Application Production Manual voor management
Nervecenter.vsd	NerveCenter graphic, used in "Service Informer - Ontwerp.doc"
Service Informer - Gegevensmodel.vsd	Graphic used in "Functional and technical design"
ServiceInformerGegevens.mdb	Database containing data for creating "Service Informer - Handleiding.doc"
Development	
Problemen en Wijzigingen.txt	File containing problems with and changes to SI.
ServiceInformer (NerveCenter).bat	Command to boot SI in the Nerve Center
ServiceInformer.mdb	MS ACCESS program – development version
ServiceInformer.mde	MS ACCESS program – user version
ServiceInformer.mic	SI logo;Microsoft Image Composer format
ServiceInformer.bmp	Bitmap format
ServiceInformer.gif	JPG format
ServiceInformer.jpg	MS EXCEL spreadsheet for creating cross reference tables
ServiceInformer.xls	
ServiceInformerGegevens.mdb	MS ACCESS database; data as used during development
Presentations	
Presentatie Stuurgroep 1999-09-10.ppt	
Presentatie Agora-CIA.ppt	
ServiceInformer	
Default.Htm	Initial page for opening the Intranet
Info.Htm	Information page
Kop.Htm	Header at top of page according to Agora standard

Menu.Htm	Menu below heade[redacted]ording to Agora standard
Graphics	
Demonstratie.htm	Test page for displaying small regional maps
Pixel.gif	1-pixel graphic (invisible)
ServiceInformer.jpg	SI logo; JPEG format
Goed.gif Storing.gif	Button – OK situation (green)
Stop-gif	Button – Failure situation (red)
Tab25.gif	Invisible graphic of 25 pixel length for tabulation
Client data	
Achtergrond.gif	Small map for the correct (green) situation
AmsterdamStop.gif	Amsterdam with a stop situation
AmsterdamStoring.gif	Amsterdam with a failure situation
ArnhemStop.gif	
ArnhemStoring.gif	
BredaStoring.gif	
BredaStop.gif	
Den BoschStop.gif	
Den BoschStoring.gif	
Den HaagStop.gif	
Den HaagStoring.gif	
GroningenStop.gif	
GroningenStoring.gif	
HaarlemStop.gif	
HaarlemStoring.gif	
HengeloStop.gif	
HengeloStoring.gif	
LeeuwardenStop.gif	
LeeuwardenStoring.gif	
MaastrichtStop.gif	
MaastrichtStoring.gif	
RotterdamStop.gif	
RotterdamStoring.gif	
UtrechtStop.gif	
UtrechtStoring.gif	
Zwollestop.gif	
ZwolleStoring.gif	
Districts	
Achtergrond.gif	Graphic showing the correct (green) situation
Rayon Indeling.txt	Arrangement of districts across the districts
Rayon MiddenStop.gif	Central district showing a stop situation
Rayon MiddenStoring.gif	Central district showing a failure situation
Rayon NoordoostStop.gif	
Rayon NoordoostStoring.gif	
Rayon NoordwestStop.gif	
Rayon NoordwestStoring.gif	
Rayon ZuidoostStop.gif	
Rayon ZuidoostStoring.gif	
Rayon ZuidwestStop.gif	

Rayon ZuidwestSto[redacted]if

Fixed telephony	
Achtergroud.gif	Background showing the correct (green) situation
AW0Stop.gif	AWO showing a stop situation
AW0Storing.gif	AWO showing a failure situation
CIAStop.gif	
CIAStoring.gif	
KanvasStoring.gif	
KanvasStop.gif	
NumbesStop.gif	
NumbesStoring.gif	
Poster0rigineel.jpg	
Ruimte.gif	Invisible graphic, 1 pixel wide and of equal height as Achtergrond.gif
Application	
ServiceInformer.bmp	SI logo; BMP format
ServiceInformerGegevens.indb	Service Informer – Operational data
ServiceInformer.mde	Service Informer – Program
Css	
Agora.Css	Cascading Style Sheet according to Agora standard
Graphics	
Pic_Mail.Gif	E-mail graphic according to Agora standard
Pic_Top.Gif	Go-to-top graphic according to Agora standard
Topagora.Gif	Home graphic according to Agora standard
Toplogo.Gif	Agora logo
Topnavi.Gif	Navigation graphic according to Agora standard
Java	
menu.js	Java script for menu control according to Agora standard
Templates	
StatusKop.htm	Standard header lines for generated status pages
StatusVoet.htm	Standard footer lines for generated status pages
Status	
Status.htm ... Status999.htm	Status pages generated by SI

Nervecenter Pilot KPN Datacenter

Service Informer Design

Contents

1. Introduction

The KPN Nervecenter helps in making the step from infrastructure to service management. One of the parts of this is timely informing the client in regard to failures and the time required to resolve them. This informing of the client is supported by an Intranet on which the current status of the various services is displayed in understandable language for the client.

1.1. Objective of this document

This document describes the constraints, the functional and technical design of the Intranet site which forms part of the Nervecenter project.

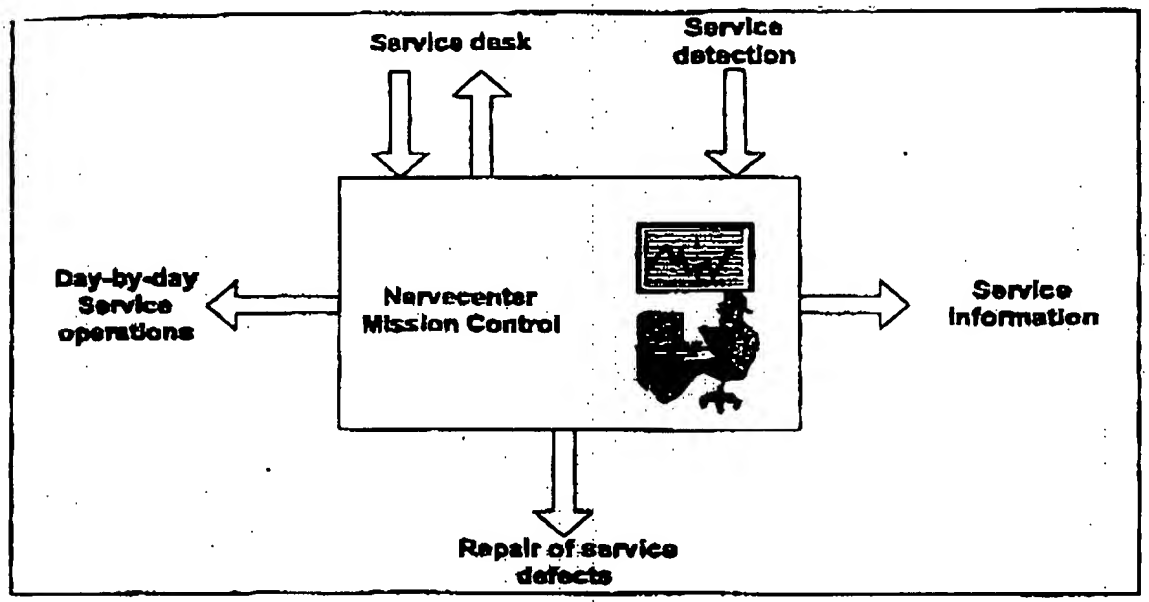
1.2. Distribution list

"Click here and type distribution list"

2. The Nervecenter Intranet environment

2.1. The general structure

The Nervecenter is represented by the conceptual drawing below:



The Nervecenter is a central place where all communication takes place:

- **The Service desk** maintains contact with the clients by registering incidents and their progress.
- **Service detection** monitors all services, and registers correct functioning and possible deviations from standard settings.
- **Repair of service defects** responds to incoming 'complaints' and performs repair operations, while
- **Day-by-day Service Operations** performs daily operations such as creating new users and carrying out routine tasks.
- Finally, **Service Information** reports the status and progress of all these activities to users, clients and management. Examples: Current Status, Outstanding Problems and Implemented/Planned changes.

2.2. Service information via the Intranet

2.2.1. Introduction

The Intranet, on which this document is focussed, is the implementation of the Service Information part of the Nervecenter. Before the details of this Intranet are discussed, two other implementation possibilities are considered first: The manual method and Complete integration. By discussing both possibilities beforehand, a foundation is laid down for the ultimate implementation selection: the currently feasible happy mean.

2.2.2. The manual method

The (technically) easiest method for implementing the Nervecenter is to set up a location with a number of telephones. The staff at this location 'calls around' to collect information and is called by the outside world.

Of course it is obvious that this is impractical. The significance of this suggestion is that such a central service monitoring point, rather than highly sophisticated technical solutions, should be the objective of the Nervecenter.

Although charming in its technical simplicity, this option must be disregarded since an on-line information facility is not feasible.

2.2.3. Complete integration

Of course it is also possible to equip the Nervecenter with a maximum of tools:

- The **Service desk** is set up around a Service Management package containing all Services and underlying IT components.
- **Service detection** automatically registers all events that occur in the Service Management environment (trouble tickets).
- **Repair of service defects** is driven by the Incidents and Problems entered, while
- **Day-by-day Service Operations** performs the operations on the basis of the agreed Changes in the Service Management package.
- For **Service Information** it is then ultimately easy to take care of the information facility: all information is centrally present in the database of the Service Management package.

Such a complete integration certainly has its merits: all information regarding all IT components is centrally available; both the statistical information (name, type, number) and the status (correct, failure, stop) and the relationship with all services are then stored, so that the provision of information is optimal. All possible questions can be answered by querying the central database! This option is interesting because of its completeness, but must be disregarded because of its technical complexity.

2.2.4. The Nervecen[redacted]ntranet

After the two previous possibilities, representing the extremes of a technically very simple solution and a technically very complex solution, a third option is now considered: a middle course which makes use of modern resources but which can be overseen in regard to technical complexity and can be implemented within a reasonable time span.

The **Service Information** part of the Nervecenter is implemented by a small application called **Service Informer**, functioning alongside the other Nervecenter components. This independent component is responsible for the information provision of the Nervecenter to the client.
The information can be retrieved from a web browser by the client, and forms part of the Agora Intranet of KPN Telecom.

Service Informer is manually fed from the incidents database. The incidents database is filled on the basis of messages from the helpdesk, the experience of various management groups, and events discovered by Patrol.

3. Functional design

3.1. Introduction

The Nervecenter Intranet provides services users of KPN Datacenter services insight into the functioning of those services. The following information is available:

- The current service status: a summary of the currently outstanding incidents.

In the future, the following data will also be made available through the Intranet:

- Information regarding service changes. This applies to future changes, but also to recently implemented changes. Recent changes can indicate current errors, while future changes can provide a warning for future failures.
- Information regarding known errors. Users can consult this list first to see whether a solution for the error that has occurred is already available.

A very important requirement for the Nervecenter Intranet is that all information is presented from the viewpoint of the user.

3.2. Current service status

The Nervecenter provides a pilot for CIA (Client-order Input Application). This application has the following menu structure:

Login
Login CIA
Login CIA
Change password
End of program

Connections
- New construction
- Migration (ISDN)

Move
Change infrastructure
Abort
Outporting
Installation task
AWO direct

Client info
DBI
BILLIT
NUMBES

Primarent
New rent contract
End T65-T88 rent contract
End rentcontract

Invoice telcorder

Return within 8 days
Exchange apparatus
Replace defect apparatus
Change serviceform
Take over rentcontract
Request rentcontract

Administrative tasks
- Take over contract
- Correct client name
- Database
- Change invoice number
- Note-address change
- Note-form change
- Request database
- Screen number
- Change form subscription
- Stop

Client info
- DBI
- BILLIT
- NUMBES

Messages
- Message of the day

Information display to users is always based on the above structure.

The IT Infrastructure managers, however, look at this in another way! Depending upon their position and/or competence, they think in terms of Tuxedo transactions, Application Servers or Windows NT Systems. **The job of the Service Informer is to translate from technology to user functions.**

In general, it can be said that an application has user functions which, in turn, are dependent upon IT components. All these matters, however, can be represented by a generic "component". Each component may be dependent upon one or more components. Each component may also influence other components.

When a user requests data, he is interested only in the status of an application (including the thereto related functions). The status of underlying components is irrelevant. For this reason, each component also has a type (ComponentType), the type of the component determining whether or not it is relevant for the client.

3.3. Reporting failures

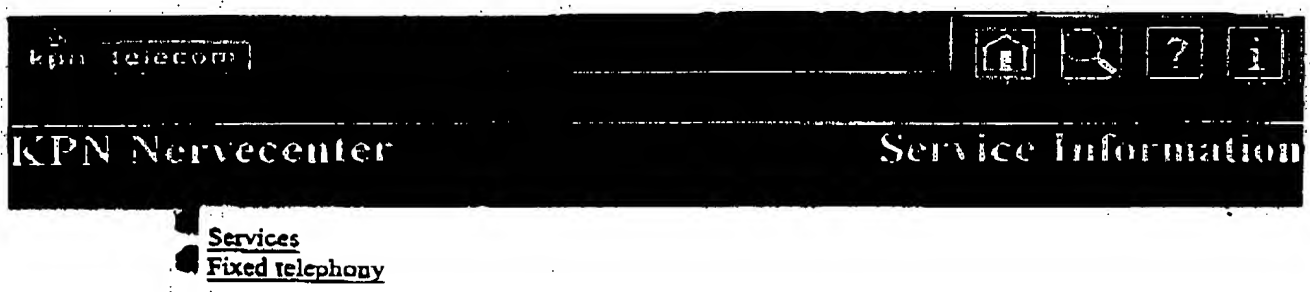
Failures in the IT infrastructure can be reported on each component. A failure has an effect on the service (EffectOpService): Geen (*None*), Storing (*Failure*) or Stop. Each component influences the status of all other components which are dependent upon it. This continues to the 'highest' level, until the component found has no higher component.

3.4. Requesting the current status

The status of applications and application functions can be requested through the Intranet site.

3.4.1. Status page

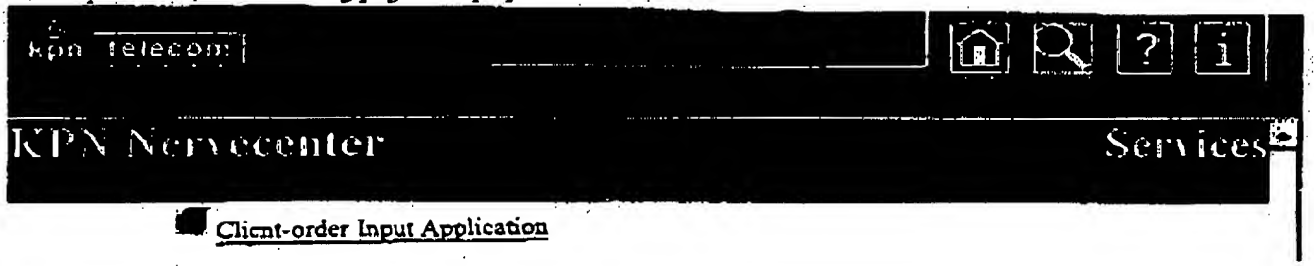
The first page shown displays the status information at the highest level:



A choice can be made between detailed information regarding Services or an overall fixed telephony overview.

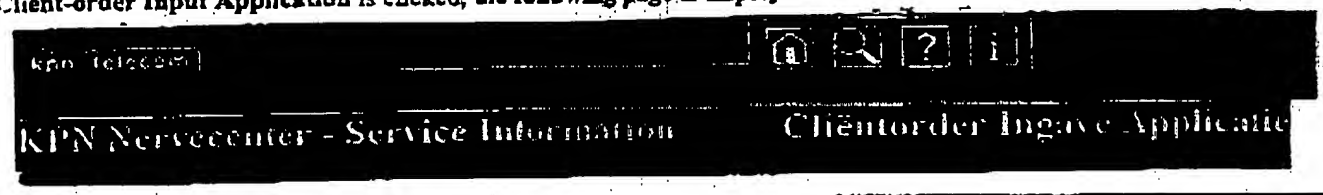
3.4.2. Status of applications

If Services is clicked, the following page is displayed:



3.4.3. Status Client-order Input Application

If **Client-order Input Application** is clicked, the following page is displayed:



Connections	Primarent	Administrative tasks
1. New construction	1. New rent contract	1. Take over contract
2. Migration (ISDN)	2. End T65-T88 rent contract	2. Correct client name
3. Move	3. End rentcontract	3. Database
4. Change infrastructure	4. Invoice teleorder	4. Change invoice number
5. Abort	5. Return within 8 days	5. Note-address change
6. Outporting	6. Exchange apparatus	6. Note-form change
7. Installation task	7. Replace defect apparatus	7. Request database
8. AWO direct	8. Change service for	8. Screen number
Client info	9. Take over rentcontract	9. Change form subscription
1. DBI	10. Request rentcontract	0. Stop
2. BILLIT	11. End with contractor	Messages
3. NUMBES		Message of the day

In the event of application functions for which a failure has occurred (yellow or red), a page displaying a failure overview can be accessed by means of a reference.

3.5. Detailed failure information

In the event of a failure, the following is displayed on the Intranet:

Failures for this or underlying components
Database Breda is down

Time:	The failure started on 1999/09/28 at 11:00:00.
	The problem is expected to be resolved on 1999/09/28 at 15:00:00.
Reference:	The reference number of the failure is TARGET 776
Component:	AWO Database Breda
Effect:	Client data: Breda
	Districts: All

3.6. Effect on client data and work locations

As can be seen in the detailed data of the above failure, a failure may be general, or limited to one or more databases with client data. This information is graphically displayed on the intranet pages as shown in the accompanying figure:

The failure reported only impacts the client data in Breda.

Client data

The same applies for the work site: the place where the application is used.
Since in the example the failure does not impact a specific work site, they all remain GREEN.

Attention: of course all work sites will still have problems with the data of clients in Breda.

Districts

4. Technical design

4.1. Status transfer between components

When a component failure is reported, it impacts all 'higher' components, that is to say, the components which are dependent upon that component. This chapter describes the process of how the status of 'higher' components is determined.

First a simple algorithm is described, after which the final algorithm is determined.

It would be possible to establish the status of the components using a recursive algorithm, and then to create the HTML pages directly. This option is not chosen, however, since the status of the components is then not directly visible for the maintenance program (only from the web site) and such an approach results in a heavier load on the database system (all required information must be generated over and over).

4.1.1. Basic algorithm

Failures are reported on components. These components impact other components in a rising line, until the highest hierarchy level is reached. The algorithm for this transfer functions is as follows:

1. As a first step, the status (ComponentStatus) of all components is set to 'Goed' (*Correct*), as though no failure whatsoever is present.
2. Next, all failures are read (Afgesloten = FALSE and EffectOpService > Geen, i.e. *Closed = FALSE and EffectOnService > None*). For each failure, the status of the related component is made equal to that of the failure, provided ComponentStatus < EffectOpService (i.e. *ComponentStatus < EffectOnService*). This latter condition is required, since several failures are possible for a component.
   During this process, all component numbers (ComponentNr) of changed components are simultaneously saved; this list is called ComponentNummers (i.e. *ComponentNumbers*).
3. Subsequently, all dependencies (Afhankelijkheden) are read for which ComponentNr2 (i.e. *ComponentNumber2*) occurs in the list ComponentNummers. These components have been changed and can thus change upstream components. The status of ComponentNr1 is now made equal to that of ComponentNr2 (provided the ComponentStatus is increased). During this process, all component numbers (ComponentNr) of changed components are simultaneously saved; this list is called ComponentNummers (i.e. *ComponentNumbers*).
4. The previous step is repeated until no further dependencies (Afhankelijkheden) are found.

As a result, the (transferred) status of all components is directly known, without having to consult underlying components. The underlying component which caused the problems, however, cannot be retrieved directly without retrieving this information "downstream". To this end the table StatusOorzaak (i.e. *StatusReason*) is used, the process described above being extended as follows.

4.1.2. Extended algorithm

Failures are reported on components. These components impact other components to an increasing extent, until the highest hierarchy level is reached. The algorithm for this transfer functions is as follows:

1. As a first step, the status (ComponentStatus) of all components is set to 'Goed' (*Correct*), as though no failure whatsoever is present.
2. Next, all failures are read (Afgesloten = FALSE and EffectOpService > Geen, i.e. *Closed = FALSE and EffectOnService > None*). For each failure, the status of the related component is made equal to that of the failure, provided ComponentStatus < EffectOpService. This latter condition is required, since several failures are possible for a component.
   The failure data are also copied to OnderliggendeStoring (i.e. *UnderlyingFailure*), so that the failure causing the ComponentStatus is directly visible at the component level.
   During this process, all component numbers (ComponentNr) of changed components are simultaneously saved; this list is called ComponentNummers (i.e. *ComponentNumbers*).
3. Subsequently, all dependencies (Afhankelijkheden) are read for which ComponentNr2 occurs in the list ComponentNummers. These components have been changed and can thus change upstream components. The status of ComponentNr1 is now made equal to that of ComponentNr2 (provided the ComponentStatus is increased).
   The data are of the OnderliggendeStoring (of Component 2) are also copied to StatusOorzaak, so that the failure causing the ComponentStatus is again directly visible at the component level.
   During this process, all component numbers (ComponentNr) of changed components are simultaneously saved; this list is called ComponentNummers (i.e. *ComponentNumbers*).
4. The previous step is repeated until no further dependencies (Afhankelijkheden) are found.

4.1.3. Addition of client and district dependencies

In Service Informer, two special component types can be entered which represent KlantRegio (i.e. *ClientRegion*) and the WerkRegio (i.e. *WorkRegion*). Both component types can comprise a maximum of 24 components and these components must be numbered from 1 ...24.

The reason for this is that the component numbers can be stored together in one binary 24-bit register, which will be used when transferring the dependencies of KlantRegio and WerkRegio.

Each component has a register KlantMask (i.e. *ClientMask*) and WerkMask (i.e. *WorkMask*). These masks initially contain OxFFFFFF, meaning: all regions.

It is subsequently determined per component whether the component has been made DIRECTLY dependent upon KlantRegio or WerkRegio (by adding a dependency of a component of such a type). For each applicable component, the KlantMask and the RegioMask are made equal to the sum of the second power of the KlantRegio or Werkregio number.

This number is subsequently taken along in the previously described 'Status transfer process' with the OnderliggendeStoring (i.e. *UnderlyingFailure*) assigned to a component: when a component is dependent upon a specific KlantRegio or WerkRegio, the failure for that component of course impacts only that KlantRegio or WerkRegio.

If a failure is transferred to a component which itself is again specific for a certain KlantRegio or WerkRegio, the information for the OnderliggendeStoring is adapted using an AND function: the failure is then only related to that KlantRegio or WerkRegio on which both the underlying component AND the thereto related component have impact.

When an underlying failure (OnderliggendeStoring) is created for a component, and this failure was already created via another route, the KlantRegio and WerkRegio information of the underlying failures are added together (OR function). In this way it can be established for each failure at the component level whether the failure is general (all client or work regions) or whether the failure is restricted. This can then be visualised, as shown above, with the KlantRegio and WerkRegio maps.

4.2. Creating a status overview

4.2.1. Highest level; Status.htm

First a status page (Status.htm) is generated which, at the highest level, indicates the status of the infrastructure. This page comprises all component types for which the option GenereerStatusPagina = TRUE (i.e. *GenerateStatusPage = TRUE*). Detailed information for each component type can be retrieved by means of a hyperlink.

4.2.2. Component type level

For each ComponentType (with the option GenereerStatusPagina = TRUE), a status page is generated which shows the status of the underlying structure. For example, the following pages could be created:

- ApplicatieStatus (i.e. *ApplicationStatus*)
- TransactieStatus (i.e. *TransactionStatus*)
- LocatieStatus (i.e. *LocationStatus*)

These pages contain one line for each component at the highest level, which subsequently refers to an underlying page in which the whole structure of dependent components of the same type is included. The name of this underlying page is generated by means of the main page and the component number (ComponentNr).

End users will usually focus on the application status page (ApplicatieStatus). As soon as this page indicates that there are problems in an application, they can click the related application reference to find the underlying application parts where the problem has occurred.

4.3. Intranet directory structure

<root>	
./Afbeeldingen (i.e. *./Graphics*)	All graphic images.
./Java	All Java scripts.
./Status	All generated pages.
./Sjablonen (i.e. *Templates*)	Templates for generating status pages.
./Applicatie (i.e. *Application*)	Directory with MS ACCESSS management program.

4.4. Graphics

4.4.1. Client and work regions

Client regions (Klantregio) and work regions (Werkregio) are graphically represented, but Service Informer itself knows nothing of these components. The manner in which these components are depicted is as follows.

1. In the settings, a component type is assigned to a client region (KlantRegio) and a work region (WerkRegio). In the CIA situation, these are the component types Klantgegevens (i.e. *Client data*) and Rayon (i.e. *District*) respectively. In the graphics directory (Afbeeldingen), two subdirectories must therefore be creating with the same names.
2. In order to be able to depict the correct situation (Goed), these two directories must contain the background graphic Achtergrond.gif. This graphic shows The Netherlands with 13 green districts. This graphic must be no greater than 200x200 pixels.
3. The components of type Klantgegevens (i.e. Client data) have the names 'Arnhem' ... 'Zwolle'. These districts can have the status of Storing (i.e. *Failure*) and Stop, and should therefore comprise two graphics for each component: ArnhemStop.gif and AmhemStoring.gif... ZwolleStoring.gif.
4. The related pages first display the background graphic Achterground.gif and then, superimposed, the failing components. These graphics have exactly the same size as the background, but contain only the component in yellow or red.

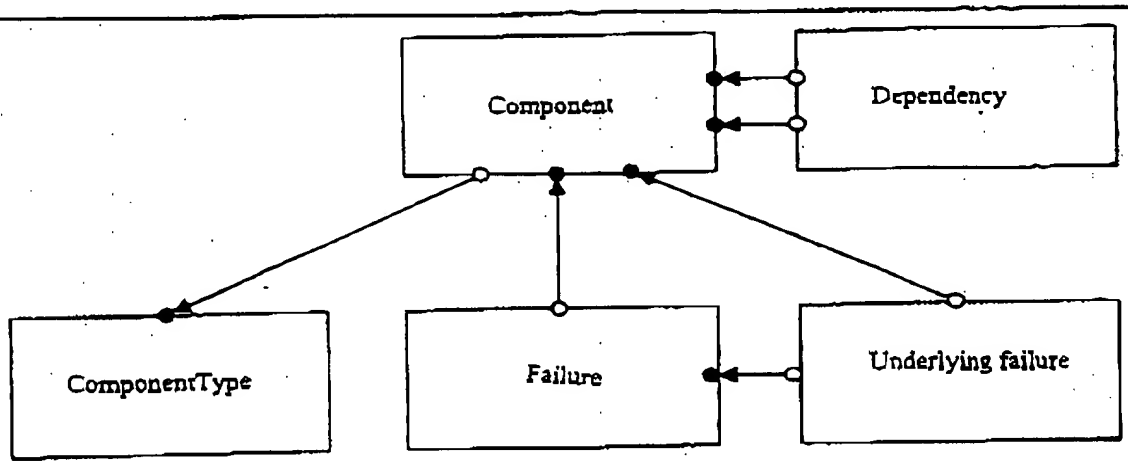
4.4.2. Graphically represented component types

Graphically represented component types function in a similar manner as described above:

1. In directory Afbeeldingen (i.e. *Graphics*) a subdirectory must be created which has the same name as the component type.
2. This directory must contain two graphics: Achtergrond.gif (Background.gif) and Ruimte.gif (Space.gif). Ruimte.gif is 1 pixel wide and has the same height as Achtergrond.gif.
3. For each component within this type, two graphics <ComponentNaam>Storing.gif (i.e. *<ComponentName>Failure.gif*) and <ComponentNaam>Stop.gif (i.e. *<ComponentName>Stop.gif*) must exist.

4.5. Data model

Table	Description
Instellingen (i.e. *Settings*)	Various parameters for the application function.
ComponentType	A component type, for example Applicatie (i.e. *Application*), Transactie (i.e. *Transaction*) or IT component.
Component	An application function or IT component.
Afhankelijkheid (i.e. *Dependencies*)	The dependencies between two components.
Storing (i.e. *Failure*)	An event which is registered for one component.
OnderliggendeStoring (i.e. *UnderlyingFailure*)	An event for a component which is related to an underlying component.



4.5.1. Settings

Column	Type	Length	Unit / Remarks
InstellingenNr (*SettingsNumber*)	Numeric		Unique code for internal use.
IntranetPad (*IntranetPath*)	Alphanumeric	255	Path in which Intranet web pages are stored.
IntranetURL	Alphanumeric	255	URL where the Intranet pages can be found.
KlantComponentTypeNr (*ClientComponentTypeNumber*)	Numeric		The component type number of the components which display the client region (KlantRegio).
WerkComponentTypeNr (*WorkComponentTypeNumber*)	Numeric		The component type number of the components which display the work region (WerkRegio).
RegioInfo (*RegionInfo*)	Numeric		Manner in which client/work regions are displayed. 0 = None 1 = Matrix 2 = Map

Fixed settings:

Graphics	Are expected in <IntranetLTRL>/Afbeeldingen.
Status correct icon	For this, <IntranetURL>/Afbeeldingen/Goed.gif is used.
Status failure icon	For this, <IntranetURL>/Afbeeldingen/Storing.gif is used.
Status stop icon	For this, <IntranetURL>/Afbeeldingen/Stop.gif is used.
Status pages	Are stored in <IntranetPad>/Status and expected in <IntranetURL>/Status. The first page is called Status.htm.

4.5.2. ComponentType

Column	Type	Length	Unit / Remarks
ComponentTypeNr (*ComponentTypeNumber*)	Numeric		
ComponentTypeNaam (*ComponentTypeName*)	Alphanumeric	100	For example: 1 = Application 2 = Transaction 3 = IT component
GenereerStatusPagina (*GenerateStatusPage*)	Boolean		TRUE: an information page for this level is generated.
StatusPaginaNaam (*StatusPageName*)	Alphanumeric	100	The name of the status page to be generated.
ComponentStatus			Status of the component, derived from failures in underlying components.
Volgorde (*Sequence*)	Numeric		The order in which component types are displayed on the screen.
Grafisch (*Graphical*)	Boolean		The Intranet page must contain a graphical representation of the components (rather than a textual representation)

4.5.3. Component

Column	Type	Length	Unit / Remarks
ComponentNr (*ComponentNumber*)	Numeric		Unique code for internal use.
ComponentNaam (*ComponentName*)	Alphanumeric	100	→ ComponentType Status of the component, derived from failures for this and underlying components.
MenuStructuur (*MenuStructure*)	Alphanumeric	20	Numbering of components for applying structure to the display.
NieuwKolom (*NewColumn*)	Boolean		Indicator for starting a new column on status page.
GeenStoringen (*NoFailures*)	Boolean		No failures may be created for this component: the component is used only to group components.
Niveau (*Level*)	Numeric		Depth of the numbering used.
MenuNiveau1 (*MenuLevel1*)	Numeric		With the aid of these inputs the user indicates the hierarchy in the overview.
MenuNiveau2 (*MenuLevel2*)	Numeric		
MenuNiveau3 (*MenuLevel3*)	Numeric		
KlantMask (*ClientMask*)	Numeric		The sum of 2 ^^MenuNiveau1 of all components of type KlantRegio (*ClientRegion*) which are assigned to this component. 0xFFFFFF = all regions
WerkMask (*WorkMask*)	Numeric		As for WerkRegio (*WorkRegion*).

4.5.4. Dependency

Column	Type	Length	Unit / Remarks
ComponentNr1 (*ComponentNumber1*)	Numeric		→ Component.
ComponentNr2 (*ComponentNumber2*)	Numeric		→ Component.

Component 1 is dependent upon Component 2.

4.5.5. Failure

Column	Type	Length	Unit / Remarks
StoringNr (*FailureNumber*)	Numeric		Unique code for internal use.
ComponentNr (*ComponentNumber*)	Numeric		→ Component.
Afgesloten (*Closed*)	Boolean		TRUE: The failure is closed and exits only for future reference
EffectOpService (*EffectOnService*)	Numeric		1 = None 2 = Failure 3 = Stop
Omschrijving (*Description*)	Memo		
InterneOpmerkingen (*InternalRemarks*)	Memo		
Begin (*Start*)	DatumTijd (*DateTime*)		
Eind (*End*)	DatumTijd (*DateTime*)		
ExterneReferentie (*ExternalReference*)	Alphanumeric	100	Reference, for example to service management package. Target = Incident #

4.5.6. Underlying failure

Column	Type	Length	Unit / Remarks
ComponentNr (*ComponentNumber*)	Numeric		→ Component.
StoringNr (*FailureNumber*)	Numeric		→ Storing (*Failure*) The failure which was transferred to this component.
KlantMask (*ClientMask*)	Numeric		The client regions (KlantRegio) to which the underlying failure (OnderliggendeStoring) applies. 0xFFFFFF = all regions
WerkMask (*WorkMask*)	Numeric		As for work regions (WerkRegio).

4.6. Access control and user profiles

In the first version of the program, access control and/or user profiles is not provided. Access control can be implemented by placing in the software in a protected directory in the network.